CLAIMS

1. Process for the wet fractionation of cereal bran components,
characterized in
that bran is first subjected to a combination of enzymatic treatment with enzymes of the group starch- and phytate-hydrolysing enzymes, and aqueous wet milling, followed by an optional step of enzyme inactivation by wet heat treatment, and a subsequent step whereby the insoluble phase containing a cleaned bran consisting of both pericarp and aleurone fractions are separated by centrifugal forces into an aqueous phase containing a germ-rich fraction and a further aqueous phase containing residual endosperm components, and that the proteins contained in the endosperm-rich fraction are concentrated.

2. Process according to claim 1,
wherein cereal brans are the fibrous-residue resulting from a primary grain milling, i.e. after the separation of the endosperm fraction, of wheat, rice, barley, oat, rye and triticale, and having variable chemical compositions, presence of anti-nutritive factors, and presence of various anatomical fractions, i.e. pericarp, germ, and residual endosperm.

3. Process according to claim 1,
wherein the enzymatic treatment is accomplished using a starch degrading enzyme of the group of amylases and amyloglucosidases.

4. Process according to claims 1-3,
wherein a further enzymatic treatment is carried out using at least one non-starch degrading polysaccharidase in the form of cellulases, hemicellulases mainly xylanases, beta-glucanases, and pectinases, and/or phytases.

5. Process for the wet fractionation of cereal bran substantially free of soluble compounds produced according to claim 1-3,
wherein such cleaned bran is subjected to a combination of enzymatic treatment with specific enzymes of the group xylanase and/or beta-glucanase under strictly

controlled hydrolysis conditions, and intermittent wet milling, followed by an optional step of enzyme inactivation by wet heat treatment.

6. Process according to claim 5,
wherein the inactivated hydrolysate is then fractionated by centrifugal forces into an insoluble phase containing primarily cellulose, lignin, less accessible hemicellulose, residual aleurone cells and cell wall bound proteins, and an aqueous phase containing soluble hemicellulose, oligosaccharides, sugars and proteins, and that the aqueous phase is further separated by centrifugal force into protein-rich fraction and a carbohydrate-rich fraction, and that the carbohydrate-rich fraction is further separated by size exclusion technique into a hemicellulose-rich fraction (medium molecular size fraction) and an oligosaccharide-rich fraction (small molecular size fraction).

7. Process according to claims 5-6,
wherein cereal bran substantially free of both in water or less polar solvents soluble compounds are derived from wheat, rice, barley, oat, rye or triticale.

8. Process according to claims 1 and 5-7,
wherein the combination of intermittent wet milling with enzymatic treatment is arranged to increase the rate of enzymatic hydrolysis of the substrate thereby improving the overall hydrolysis performance and the subsequent separation of the various fractions by density/solubility and molecular size.

9. Process according to claims 5-8,
wherein the enzymatic treatment is carried out using at least one non-starch degradable polysaccharidase in the form of cellulases, hemicellulases mainly xylanases, beta-glucanases, and pectinases, and optionally phytases.

10. Process according to claim 9,
wherein the enzymatic treatment is accomplished by using xylanases with high beta 1-4- xylanase (pentosanase) and/or beta-glucanase activity.

11. Protein fraction derived substantially from the germ and produced according to claims 1-4,
wherein the said fraction contains at least 35% protein and 10% oil on dry matter basis and exhibits a high emulsifying capacity and an increased shelf life with regards to resistance to oxidation compared to the original bran, and that the said fraction contains less than 5% fibre.

12. Protein fraction derived substantially from the residual endosperm and produced according to claims 1-4,
wherein the said fraction contains at least 25% protein and 10% sugar and less than 3% oil and 3% fibre, and at least 25% soluble high-molecular weight non-starch polysaccharides of the groups beta-glucans for barley and oat and arabinoxylans for wheat, rice, rye and triticale.

13. Protein fraction according to claim 12,
wherein liquid whey is incorporated in to the said fraction at levels varying from 20 to 80% by weight on dry matter basis, and that the final mixture is dried.

14. Insoluble fibre fraction produced according to claims 1-4,
wherein the said fraction consists of cell wall components of bran in an amount of at least 85% and aleurone proteins in an amount of at least 10%, and substantially free of gluten and starch, and with a high water holding capacity of at least 6g water/g dry product.

15. Sugar fraction produced according to claims 1-4,
wherein the said fraction is originated primarily from the residual endosperm and it contains more than 65% sugars, such as glucose, maltose and malto-triose on dry matter basis.

16. Protein fraction derived substantially from the aleurone cells and produced according to claims 5-10,
wherein the said fraction contains at least 35% protein and 10% oil, less than 5% insoluble fibre on dry matter basis, substantially free of gluten and starch and with a high emulsifying capacity.

17. Insoluble fibre fraction produced according to claims 5-10,
wherein the said fraction consists primarily of cell wall components with a relative lower hemicellulose content compared to the original cleaned cereal bran, substantially free of gluten and starch (<1% on dry matter basis) and with a high water holding capacity (>6g water/g dry product).

18. Soluble hemicellulose fraction produced according to claims 5-10,
wherein the said fraction consists primarily of medium molecular weight hemicellulose preferably above 20kDa in an amount of at least 40% of the groups arabinoxylans from wheat, rye, rice and triticale, and beta-glucans from oat and barley, which also contains proteins in an amount of less than 10% and monosaccharides in an amount of less than 10%, and is substantially free of gluten and starch in an amount of less than 1% on dry matter basis.

19. Soluble oligosaccharide fraction produced according to claims 5-10,
wherein the said fraction consists primarily of low molecular weight hemicellulose sub-units of below about 20kDa in an amount of at least 40% of the groups arabinoxylans from wheat, rye, rice and triticale, and beta-glucans from oat and barley, which also contains proteins in an amount of less than 10%, monosaccharides in an amount of less than 20%, lignans and related phenolics in an amount of less than 5%, and is substantially free of gluten and starch in an amount of less than 1% on dry matter basis.

20. Protein fraction according to claim 11,
wherein the oil can be optionally removed by conventional organic solvent extraction or preferably by supercritical carbon dioxide extraction to yield an oil fraction and a defatted protein fraction.

21. Protein fraction according to claim 16,
wherein the oil can be optionally removed by conventional organic solvent extraction or preferably by supercritical carbon dioxide extraction to yield an oil fraction and a defatted protein fraction.

22. Insoluble dietary fibre according to any claims 14 and 17, used for recovery of cellulose, hemicellulose, lignin and lignans.

23. Germ oil produced in accordance with claims 1-4 and 20 containing sterols known to reduce the uptake of cholesterol in humans and intact vitamin E complex, sterols, lecithins, phospholipids and glycolipids.

24. Defatted germ rich protein produced in accordance with claims 1-4 and 20.

25. Aleurone-rich oil produced in accordance with claims 1-10 and 21.

26. Defatted aleurone-rich protein produced in accordance with claims 1-10 and 21.

27. Protein fraction according to any of claims 11, 12, 13, 16, 24 and 26, wherein proteases are incorporated in to the said fraction in wet state and at controlled temperature and pH conditions, and the resulting protein hydrolysate has enhanced functionalities such as solubility, emulsifying and foaming capacities.

28. Use of a protein fraction, as described in claims 11, 12, 13, 16, 24, 26 and 27, in feed and food applications to replace other protein products from vegetable and animal sources.

29. Use of a protein fraction, as described in claims 11, 12, 13, 16, 24, 26 and 27, in food application as a texturizer, emulsifier, fat binder and fat replacer.

30. Use of a protein fraction, as described in claim 12 and 27, as a raw material for the extraction of soluble high-molecular weight non-starch polysaccharides.

31. Use of a protein fraction, as described in claim 12, 13 and 27, in food applications as a foam stabilising agent, whipping agent, water binder, gelling agent, and as a dietary supplement rich in soluble dietary fibre (beta-glucans and arabinoxylans) with associated health benefits such as cholesterol-reducing effects of the beta-glucans.

32. Use of a protein fraction, as described in claims 12, 13 and 27, as an additive or ingredient in foods such as baked products, processed meats, dairy products, soups and sauces, high protein drinks and health drinks.

33. Use of a fibre fraction, as described in claims 14 and 17, in feed and food applications to replace other insoluble fibrous products as a texturizing and water binding additive in processed foods particularly meat products, and as a source of dietary fibre in breakfast cereals, baked products and health products, or as a raw material for further processing to extract remaining cellulose, hemicellulose, lignin and lignans.

34. Use of a soluble hemicellulose, as described in claim 18, in feed and food applications as a gellant, thickener, foam stabilizer, emulsifier, water binder, and as a dietary supplement rich in soluble dietary fibre, and in chemical applications, or as a raw material for further processing to obtain other functional hemicelluloses.

35. Use of a soluble hemicellulose, as described in claim 18, as an additive or ingredient in foods such as baked products, processed meats, dairy products, soups and sauces, high protein drinks and health drinks.

36. Use of a soluble oligosaccharide, as described in claim 19, in feed and food applications as a functional soluble dietary fibre or low calorie sweetener, or as a raw material for further processing to extract lignans and associated phenolics such as ferulic acid, or as a feedstock for industrial fermentation.

37. Use of a soluble oligosaccharide, as described in claim 19, in confectionery formulations in combination with glucose or other sugar syrups and further concentrated to produce moisture stable products.

38. Use of a soluble oligosaccharide, as described in claim 19, in food and biomedical applications as a combined source of lignans and fermentable oligosaccharides for the conversion of lignans into active cancer-reducing agents such as enterolactones

39. Use of a sugar fraction, as described in claim 15, in feed, food and industrial fermentation applications as an energy source, flavouring agent and binding agent.

40. Set up for carrying out the process according to claims 1-4,
characterized in
that it comprises a hydrolysis vessel (1, 8 and 11), a wet mill (2), a heat exchange for enzymatic inactivation (3), decanters (4 and 7), a holding tank (6), an ultra-filter (10), and optionally at least an evaporator (13), and dryers (5, 9 and 12).

41. Set up for carrying out the process according to claims 5-10,
characterized in
that it comprises a hydrolysis vessels (1, 8 and 11), a wet mill (2), a heat exchange for enzymatic inactivation (3), decanters (4 and 7), a holding tank (6), an ultra-filter (10), and optionally evaporators (12 and 13), and dryers (5 and 9).

42. Process according to claims 1-4,
wherein the enzymatic treatment is carried out for less than 3 hours at a pH of 4 to 7.5 and at a temperature of from 50 to 90°C, at an enzymatic activity of at least 1 IU/g of substrate, preferably 200 to 1500 IU/g of substrate.

43. Process according to claims 5-10,
wherein the enzymatic treatment is carried out for less than 3 hours at a pH of 4 to 7, preferably 4.5-5.5, and at a temperature of from 35 to 80°C, at an enzymatic activity of at least 1 IU/g of substrate, preferably 200 to 1500 IU/g of substrate.